STATS506 Final Project

Analysis of 2012 US Commercial Building Energy Consumption Survey

Yanhan Si

12/6/2020

Introduction

The Commercial Building Energy Consumption Survey (CBECS) is a nationwide sample survey designed to collect information on the stock of commercial buildings in the United States, including energy-related building characteristics and energy use data. It gives a snapshot of the commercial buildings stock and energy use for the reference year in the United States.

Energy is closely related to the economic development of a country or region. Understanding the energy use and consumption of a country or region can better optimize the industrial structure.

In this project, I conducted a preliminary analysis on the 2012 CBECS data, trying to understand the total energy intensity for all major fuels among different principal buildings activity and examine the fuel usage difference in different regions.

Data and Method

2012 CBECS provides the annual major fuel consumption (thou Btu) (`MFBTU`), the square footage (`SQFT`), the principal building activity type (`PBA`) and region (`REGION`) of the surveyed commercial building. To calculate the building-level energy intensities, I created a new variable `BLEUI` equal to the annual major fuel consumption divided by the building square footage.

To produce population estimates from this survey data, CBECS provides the final sampling weight `FINALWT` which is the number of buildings in the population represented by the observation. The variable `FINALWT` accounts for different probabilities of selection and rates of participation in the survey. It is the reciprocal of the probability of being selected for the CBECS sample. Standard errors are estimated through jackknife method. This method uses replicate weights to repeatedly estimate the statistic of interest and calculate the differences between these estimates and the full-sample estimate. The variance is estimated by $\hat{Var}(\hat{\theta}) = \sum_{r=1}^{R} c_r(\hat{\theta}_r - \hat{\theta})^2$. $\hat{\theta}$ is the estimate from the full sample for θ. $\hat{\theta}_r$ is the estimate from the r-th replicate subsample by using replicate weights and c_r is the jackknife coefficient for replicate r. For the 2012 CBECS, R=197 (`FINALWT1-FINALWT197`) and $c_r = 1$ for each replicate. The calculations were performed using SAS surveymeans function.

Code can be found here.

Result

The overall average fuel energy intensity is 455,955,217 btu per square footage. Table 1 shows the average fuel energy intensity by different building activity types. We can see that the average fuel energy intensity of the food service industry is the highest, followed by office. Enclosed mail and refrigerated warehouse have very low fuel energy consumption intensity. This is intuitive as we would expect the major direct energy source of these industries to be electricity.

Table 1: Fuel Energy Intensity

Principal Building Activity	Fuel Energy intensity	Confidence Interval (95%)
Vacant	2.46e+06	(1.66e+06, 3.27e+06)
Office	6.57e+07	(5.75e+07, 7.39e+07)
Laboratory	3.31e+06	(1.55e+06, 5.07e+06)
Nonrefrigerated warehouse	1.93e+07	(1.40e+07, 2.46e+07)
Food sales	4.29e+07	(3.27e+07, 5.31e+07)
Public order and safety	5.98e+06	(3.90e+06, 8.07e+06)
Outpatient health care	1.05e+07	(7.79e+06, 1.32e+07)
Refrigerated warehouse	1.09e+06	(6.70e+04, 2.11e+06)
Religious worship	1.72e+07	(1.21e+07, 2.22e+07)
Public assembly	2.22e+07	(1.80e+07, 2.63e+07)
Education	2.52e+07	(2.14e+07, 2.90e+07)
Food service	1.16e+08	(9.77e+07, 1.35e+08)
Inpatient health care	2.05e+06	(1.40e+06, 2.70e+06)
Nursing	3.75e+06	(2.23e+06, 5.27e+06)
Lodging	9.95e+06	(7.83e+06, 1.21e+07)
Strip shopping mall	2.29e+07	(1.69e+07, 2.89e+07)
Enclosed mall	8.14e+04	(4.40e+04, 1.19e+05)
Retail other than mall	2.83e+07	(2.39e+07, 3.27e+07)
Service	4.61e+07	(3.74e+07, 5.48e+07)
Other	1.06e+07	(4.00e+06, 1.71e+07)

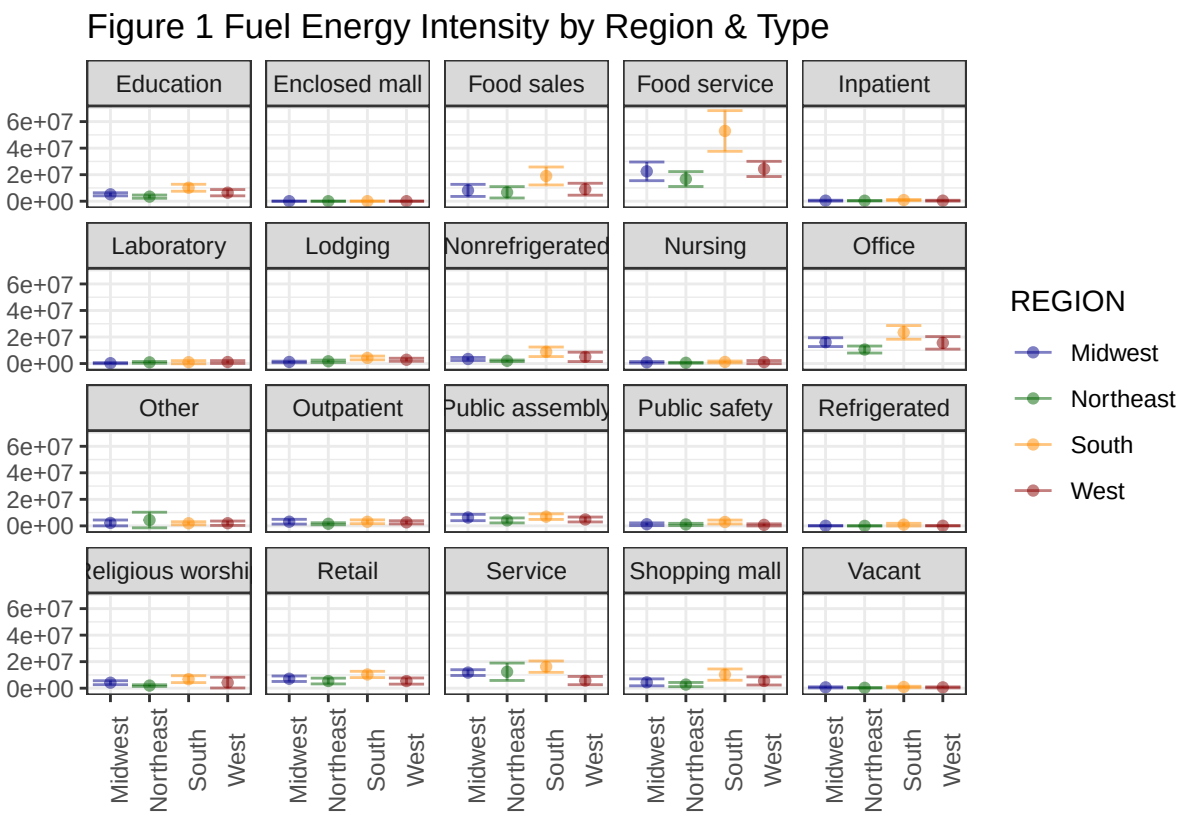

Figure 1 shows the fuel energy intensity by different regions and building activity types. As we can see, for food sales, food service, and office type of commercial buildings, the fuel energy intensity shows a significant difference among different regions. Commercial buildings in the south region have larger major fuel

consumption per square footage than other regions. For laboratory, nursing, health care, and mail service, there is no significant fuel energy intensity consumption difference.

Conclusion

In this project, I conducted a descriptive analysis of the 2012 CBECS data. The result shows that activity commercial building of the same type has different major fuel consumption intensities in different regions. Commercial buildings in the south region tend to have larger fuel energy consumption intensity than other regions.

Energy in the United States mostly comes from fossil fuels, including petroleum, natural gas, and coal. Texas is the nation's largest oil- and natural gas- producing state. We noticed from this analysis that the food industry and food sales in the south region highly rely on the fuel energy source. For industry categories that have differences in the fuel energy intensity among different regions, the south region typically leads. We also noticed that the fuel energy intensity of the food industry is much higher than other commercial types. This indicates that gas is widely used in these industries.